A NOTE ON THE PETROLOGICAL CLASSIFICATION OF THE BASIC INTRUSIVES OF DANTA STATE (N. GUJRAT).

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In a short sketch of the geology of Danta State Mr. N. L. Sharma[1] had assigned Post-Aravalli age to all the basic intrusives of Danta State. Petrological study of these rocks shows that there seem to have been at least two phases of basic intrusions between the deposition of the Aravallis and the intrusion of the Erinpura-granite. The older intrusives are more metamorphosed than the younger ones. They have been classified into Epidiorites, Hornblende-schists and Pyroxene-granulites. Epidiorites and hornblende-schists are widely distributed in the State. They are more or less confined to the "middle portion "[2] and are so intimately connected with the Post-Aravalli " Granitoid and Schistose Gneisses "[3] that it is impossible to map them separately on the 1″=1 mile map. Enclaves Enallogenes[4] of hornblende-schists in granitoid gneisses are occasionally seen in the field. Thin veins of epidiorite are sometimes found traversing the sedimentaries of the Aravalli system. Pyroxene-granulites have very limited distribution, but their mode of occurrence is similar to that of the epidiorite.

The second phase of basic intrusion is marked by the Meta-gabbro[5] and Meta-dolerite rocks which occur respectively as intrusive masses and dykes in the granitoid gneisses. These rocks are far less metamorphosed than the older intrusives. Signs of metamorphism are visible in this group of rocks only under the microscope.

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[1] N. L. Sharma, "A preliminary note on the Geology of Danta State (N. Gujrat)," *Quart. Journ. Geol. Min. and Met. Society of India,* 1931, 3, No. 1, pp. 17-28.

[2] *Ibid.*, p. 18.

[3] *Ibid.*, p. 22.

[4] S. K. Roy, "Geological and Petrographic Studies in the Hercynian Mountains around Tiefenstein," 1925, p. 55.

[5] G. W. Tyrell, *The Principles of Petrology,* 1926, p. 311.

There is yet a third group of igneous intrusives in this area which are absolutely free from all signs of original metamorphism. These are the Olivine-dolerite and Olivine-basalt which are found as dykes or sills traversing the calc-series of the Aravalli system. They are probably Post-Erinpura-Granite in age.

A short petrological description of the above rock-types is given below :—

1. Epidiorites and Hornblende-Schists. (Figs. 1 and 2.)

These rocks occur as intrusive masses, usually associated with the granitoid gneisses. Their main exposures are found in the northern half of the State, comprising the Ambamata, Vav and Ranpur areas. In the Ambamata area, the epidiorite shows a distinct intrusive relation to the Aravalli marble *with the development of garnet and epidote at the contact.* Thin dykes of epidiorite are also seen traversing the Aravalli phyllites in the bed of the Sai river at the north-eastern corner of the State.

Epidiorites are coarse-grained (dioritic) to fine-grained (basaltic) rocks greenish black or black in colour. Some of the medium and fine-grained varieties show well-defined schistose texture and may be termed hornblende-schists. A few of the specimens are calcareous and give effervescence with cold hydrochloric acid. Minute grains of pyrite and copper pyrite are visible in a specimen of epidiorite from the old copper-workings near Ambamata town.

Under microscope, these rocks show usually granoblastic, diablastic or lepidoblastic structures. Relict of ophitic structure (Fig. 1) is distinct in a section of the epidiorite from the Ambamata area. In some of the sections of hornblende-schists, glomero-porphyroblasts of hornblende (Fig. 2) are seen in a lepidoblastic groundmass composed mostly of hornblende and quartz.

In these rocks green hornblende is found to occur as an alteration product of colourless or greenish non-pleochroic diopside. In some of the specimens in which pyroxene has been completely transformed to hornblende but a relict ophitic structure is still retained, there seems to have been a certain amount of absorption of the alkali by hornblende from the felspar laths. Due to this absorption a rim, composed of an aggregate of crystals of deeper greenish blue hornblende, is developed along the margin suggesting a sort of zoning in hornblende (as is apparent from the darker band in hornblende immediately near felspar in Fig. 1). In some specimens of epidiorites hornblende has further suffered a partial alteration to biotite and magnetite.

The felspar in these rocks is plagioclase, varying from oligoclase-andesine to basic andesine in composition. It often shows undulatory extinction.

In some of the slides, felspar is fresh, whereas in others it is much saussuritised. Some epidiorites seem to contain very little felspar and are mostly composed of hornblende, quartz, calcite, epidote, zoisite and chlorite. Occasionally, sphene forms an important accessory. In the calcareous specimens, calcite seems to have been subsequently added being derived from the country rock—the calc-series.

Thus the epidiorites and hornblende-schists are highly metamorphosed basic igneous rocks. In them the pyroxene is usually diopside, and it is wholly or mostly altered to green hornblende. The original structure of the igneous rock is only rarely preserved. Enclaves of hornblende-schists are occasionally seen in the granitoid gneiss; these intrusives are, therefore, assigned to Pre-Granitoid-Gneiss age.

2. *Pyroxene-Granulite and Garnet-Granulite.* (Figs. 3 and 4.)

These rocks possess very limited occurrence. Pyroxene-granulite occurs associated with granitoid gneiss in the northern spur of Rasanio, south of Ambamata town, while veins of this rock are found traversing the calc-gneiss in a hillock near Sadanana, south-east of Danta town. Garnet-granulite occurs as an enclave in Erinpura-granite near Tarsuliaghata, north-north-east of Vav.

Both these rocks are dark-coloured. They are fine-grained in structure and possess massive texture, garnet-granulite being more compact. Under microscope these rocks show granulitic structure.

The pyroxene-granulite of Sadanana is mostly composed of greyish non-pleochroic diopside and labradorite-bytownite (Fig. 3). The felspar is quite fresh but the pyroxene is observed altering into brown hornblende (uralite) at places. A few flakes of biotite are also observed. Magnetite is the only accessory mineral of this rock.

The pyroxene-granulite of Rasanio is also composed of diopside and plagioclase; but the diopside of this rock is green and pleochroic, pleochroism being X=Z=green, and Y=yellowish brown. The alteration of diopside has given rise, probably with an absorption of alkali, to a deep greenish-blue alkali hornblende along the margin. The plagioclase felspar is oligoclase-andesine and is somewhat saussuritised. Sphene is quite abundant, and epidote and calcite are observed as secondary minerals in the rock.

Garnet-granulite is mainly composed of grossularite and labradorite-bytownite (Fig. 4). In this rock no pyroxene is found. Garnet occurs in grains and is altered to epidote and chlorite along its cracks and margin. Sometimes chlorite and epidote are found at the centre of garnet pieces. Sphene and magnetite are the accessory minerals.

As garnet-granulite occurs only as an enclave, nothing definite can be said about its origin. The pyroxene-granulites are basic intrusive rocks in which the original structure has been totally obliterated but there was not much mineralogical change. They, therefore, differ from epidiorites by the fact that in them the pyroxene is either unaltered or is only slightly altered to hornblende.

From their similar occurrence in the field, the pyroxene-granulites and the epidiorites and hornblende-schists seem no doubt to belong to the same phase of intrusion (Post-Aravalli but Pre-Granitoid-Gneiss in age) but the two rock types have most probably been subjected to different grades of metamorphism.

3. Meta-gabbro and Meta-dolerite. (Figs. 5 and 6.)

The meta-gabbro forms an isolated hillock (1791 ft. above sea-level) locally known as "Javrashia", at the southern extremity of the State. It also occurs as an intrusive mass in the granitoid gneisses between Vav and Dhaddarghata pass on the road to Badarmala. Meta-dolerite occurs as a dyke traversing the gneisses in the same locality.

The Javrashia meta-gabbro is a massive rock, greenish-black in colour, varying from coarse to medium-grained in structure. The medium-grained specimens are rather granular, very compact and hard to break. The coarse-grained variety is porphyritic showing big crystals of greenish-black pyroxene, sometimes $\frac{3}{4}$" long and $\frac{1}{2}$" wide, embedded in a matrix of felspar with small pyroxene crystals sparingly distributed in it. The pyroxene crystals show schiller effect, but generally their surface is weathered. The Vav-Dhaddarghata meta-gabbro is dark in colour, massive and coarse to fine-grained in structure. The pyroxene is black and shows schillerisation. The meta-dolerite is a dark, fine-grained and basaltic rock.

Under microscope, the Javrashia meta-gabbro shows the usual granitic structure. In other specimens, however, felspar and pyroxene show ophitic structure (Fig. 5). The fine-grained variety of Dhaddarghata area is not only ophitic, but also shows certain amount of effect of pressure by the presence of cataclastic structure of diallage (Fig. 6). The latter has also been partially uralitised.

The meta-gabbro is mainly composed of felspar (usually labradorite) and pyroxene (usually diallage). Some of the pyroxene has altered into pale-green hornblende. The rock is rather poor in opaque minerals like magnetite and ilmenite. Diallage is almost colourless in sections and sometimes shows characteristic double cleavage and parting. It gives biaxial

interference figure with positive sign. Minute opaque or semi-opaque inclusions along the cleavage planes are often observed under high magnification. Usually the alteration of diallage to greenish hornblende begins along the cleavage of the mineral or round its border, leaving the pyroxene still unaltered at the centre. At places, the hornblende crystals show double cleavage.

The diallage of fine-grained meta-gabbro, however, shows a different nature of alteration. It is altered along the border to a brown hornblende (uralite) and it is also much granulated. Occasionally, a few flakes of biotite are enclosed in diallage. The specimen of meta-dolerite shows typical ophitic structure and an abundance of unaltered augite, and not diallage, in the groundmass. Most of the phenocrysts of augite are, however, completely altered to pale-green fibrous hornblende. Magnetite is an important accessory in this rock.

The plagioclase felspar shows both albite and pericline twinning. Occasionally an indistinct zoning is observed in the plagioclase. In some specimens, the felspars show undulatory extinction. The felspar of some of the Javrashia specimens is much altered, the most common alteration product being zoisite, which occurs as big hypidiomorphic crystals inside a granular aggregate of saussurite in which some laths of unaltered felspar are observed.

An interesting dyke of meta-dolerite occurs traversing the crystalline limestone in the bed of the Sai river. It contains lenticular fragments of sheared quartz with some epidote and encrustation of kaolin along the shear planes. These fragments are 3″ or even more in length and look like enclaves. Dr. Coulson[6] has observed similar fragments in the Post-Erinpura dolerite of Sirohee State, and according to him these fragments were caught up by the basic dyke from the Erinpura-granite which was in a semi-solid state at that time.

The rock of the Sai river is, however, much metamorphosed and shows schistose structure. The planes of schistosity of the rock are continuous in the quartz fragments which are consequently much sheared. The Erinpura-granite of the neighbouring area of Harad does not show gneissose structure, whereas the granitoid gneiss at the Danta-Sirohee-Udaipur frontier is distinctly foliated. It thus seems that the quartz fragments in this rock represent probably the enclaves caught up by the basic dyke from a pre-existing pegmatite older than the Erinpura-granite. This pegmatite may

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[6] A. L. Coulson, "The Geology of Sirohee State, Rajputana," *Mem. G.S.I.*, 1933, **63**, Part I, 98.

be of the granitoid gneiss phase. Further, this rock is mainly composed of augite, epidote, zoisite with some hornblende, sphene, calcite and cryptocrystalline quartz. It looks more like an epidiorite but differs from it, like the meta-dolerite of Dhaddarghata, in the absence of diopside and an abundance of augite. One or two triangular sections of blue tourmaline are observed in this rock under the microscope. Such tourmaline crystals have also been observed by Dr. Coulson[7] in the metamorphosed basic rocks of Pre-Erinpura-Granite age, at the Sirohee-Udaipur frontier. From these characters, the rock, though highly metamorphosed, is correlated with the meta-gabbro and meta-dolerite phase of basic intrusion. Its Pre-Erinpura-Granite age is further confirmed by the fact that this dyke occurs side by side with those of olivine-dolerite containing titaniferous augite, instead of common augite. The olivine-dolerite is absolutely unmetamorphosed and is regarded as Post-Erinpura-Granite in age. None of the dykes of olivine-dolerite shows the quartz enclaves of the meta-dolerite as mentioned above.

The meta-gabbro and meta-dolerite differs from the epidiorites, hornblende-schists and pyroxene-granulites in their possessing typical structures of the basic intrusive rocks. In addition to this the pyroxene of these rocks is usually a diallage or augite, and not diopside which is the case with the older intrusives; and further, these minerals are less altered than the pyroxene of the epidiorites. These rocks cannot be called proper gabbros and dolerites as they have undoubtedly undergone some degree of metamorphism, due to which the diallage or augite has been altered partially to hornblende, and also there has been a certain amount of granulation of minerals giving rise to occasional cataclastic structure. Rarely their original structure is completely obliterated, as has been seen in case of the meta-dolerite from the Sai river. These rocks represent an intermediate phase between highly metamorphosed epidiorites and pyroxene-granulites on the one hand, and unmetamorphosed olivine-dolerite and olivine-basalt on the other. A small pegmatite containing tourmaline is found traversing the Javrashia meta-gabbro near its junction with the Erinpura-granite, and the meta-dolerite dyke traverses the granitoid gneiss in the Dhaddarghata area. These basic intrusions have, therefore, been assigned to Post-Granitoid-Gneiss but Pre-Erinpura-Granite age.

4. Olivine-dolerite. (Figs. 7-12.)

This rock occurs as dykes and sills traversing the crystalline limestone, and is best seen in the bed of the Sai river at the north-eastern corner of the State. These dykes and sills are seldom more than 4 ft. in thickness.

[7] *Ibid.*, p. 48.

In hand specimen, the olivine-dolerite is a dark-coloured massive rock varying from medium to fine-grained in structure. Some of the medium-grained specimens show grains of pyrite or amygdules of calcite. In one specimen, amygdules of calcite and quartz are so abundant that they give a spotted appearance to the rock. The fine-grained variety is basaltic in appearance, but small needle-like laths of white felspar can be easily seen embedded in the dark matrix. Most of the specimens are calcareous and give effervescence with cold hydrochloric acid.

Under microscope, the rock is seen to be essentially composed of titaniferous augite, basic labradorite and some olivine. The augite is pink in colour and is slightly pleochroic from pink to greenish yellow. The felspar occurs as long laths and shows typical ophitic structure with augite (Fig. 7). Sometimes two or even three twinned laths of felspar penetrate and cross each other as if pushing the two halves of a lath asunder (Fig. 8). The augite is idiomorphic in habit and often forms wedge-shaped plates between columnar crystals of felspar. Sometimes the felspar laths enclose between themselves rhombic, hexagonal or even octagonal sections of augite. Occasionally one or two small laths of felspar are seen to be wholly included within an augite crystal. In the fine-grained dolerites, most of the augite occurs as small grains in the ground-mass (Fig. 8).

The alteration of augite is interesting. Some of the titaniferous augite of these rocks is altered into brown biotite and magnetite and also ilmenite. The alteration usually begins along the periphery and cracks; but sometimes the whole crystal is changed, as wedge-shaped sections of biotite enclosed within ophitic felspar are quite common. Further the brown biotite so formed is sometimes seen to change first into green biotite[8] and then into green chlorite with calcite and magnetite.

Pseudomorphs of augite, enclosed between felspar laths and composed of biotite and magnetite with chlorite or calcite (Fig. 9) are very common. Some of these pseudomorphs look like amygdules of calcite bounded by chlorite (Fig. 10). The calcite, however, shows a sinuous margin with chlorite and is often full of dust-like inclusions of magnetite. The form of some of these amygdules is octagonal resembling augite. It seems that the chlorite has been replaced by calcite at a later stage. Felspar laths are sometimes seen enclosing triangular patches of pure calcite (Fig. 11) giving rise to ophitic structure. The felspar laths at the contact with this triangular patch of calcite sometimes show an indistinct zoning, their margins being more altered than the interior. This seems to confirm the view that the

[8] Winchell, N. H. and A. N., *Elements of Optical Mineralogy*, Part II, p. 369.

augite was probably first changed to biotite and then to chlorite which was subsequently replaced by calcite. This change is so characteristic that in some rocks which show, even in hand-specimens, amygdules of calcite and quartz, there is practically no augite left unchanged. In these specimens, it is calcite with dusty magnetite, enclosed within felspar, which gives rise to the ophitic appearance.

The felspar laths usually show carlsbad and albite twinning and sometimes also pericline twinning. In addition to their characteristic cleavage, they are all traversed by traverse cracks. The felspar is partly altered to a crypto-crystalline aggregate of calcite and kaolinite, with occasional flakes of chlorite or micaceous material. At places long needles of zoisite showing characteristic ultra-blue polarisation colours are seen to penetrate into or across the felspar laths.

The olivine is colourless, always altering into pale-green serpentine. It usually occurs in idiomorphic rhombic sections or as short prisms terminated by pyramidal faces (Fig. 12). The sections of olivine are usually included in plagioclase laths. The mineral was, therefore, the first to crystallise from the magma. It is usually altered along the border into magnetite, but sometimes it is completely changed into a mass consisting of magnetite, calcite and quartz, the magnesium being probably removed and replaced by calcium.[9]

This rock differs from the meta-gabbro and the other older intrusives, described before, by the presence of titaniferous augite and olivine, in the peculiar mode of alteration of the pyroxene, and in its almost unmetamorphosed nature. The olivine-dolerite is, therefore, assigned to the youngest phase of intrusions.

5. Olivine-Basalt. (Figs. 13-16.)

This rock occurs as very thin veins traversing the crystalline limestone of Sai river and the calc-gneisses of Godda and Danta areas. The veins are sometimes only 2″ in thickness.

In hand-specimen the rock is very fine-grained and massive. It is much darker in colour than the olivine-dolerite. Most of the specimens are calcareous.

The rock-slice of the Sai basalt shows, even with naked eye, numerous sub-parallel and intersecting veinlets or stringers of quite transparent calcite in greyish matrix. Under microscope, the rock shows porphyritic structure and is composed mostly of felspar, magnetite and calcite (Fig. 13). The

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[9] *Ibid.*, p. 169.

felspar which is basic labradorite, occurs in rectangular laths which are mostly altered into calcite. Some sections show both albite and carlsbad types of twinning. The interpenetration of two laths of twinned felspar, like that in olivine-dolerite, is also observed. The laths of felspar are embedded in a groundmass of magnetite, altered felspar and calcite. The habit of magnetite is usually acicular, the needles sometimes lying close and parallel to one another as if formed along the cleavage cracks of some mineral. Some of the bigger sections of magnetite appear in the triangular form of the ophitic augite, and some appear hexagonal and rhombic like olivine. Ophitic felspar laths often enclose triangular patches made up of calcite and magnetite. It, therefore, seems that the rock is a highly altered olivine-basalt in which the augite and olivine are completely altered into magnetite or replaced by calcite. The stringers of calcite often cut across the felspar laths showing thereby that the replacement has been subsequent to the formation of felspar phenocrysts.

The specimen of olivine-basalt from the Godda area differs from the above in containing numerous amygdules of calcite (Fig. 14). No stringers of calcite are observed. The rock also contains many hexagonal and rhombic phenocrysts of olivine which have been completely altered into green serpentine, showing ultra-blue polarisation colours. Sometimes the cores of such serpentinised phenocrysts are altered into magnetite. The groundmass is composed mostly of opaque iron minerals, microlites of felspar, and calcite.

The specimen of olivine-basalt from the Danta area differs from the other two, described above, in not having so much calcite. It is, however, very rich in iron. The groundmass is almost opaque consisting mostly of magnetite, leucoxene and microlites of more or less altered felspar. The phenocrysts of felspar and colourless olivine are, however, fresh and unaltered (Figs. 15 and 16). Felspar laths generally show a rough ophitic structure enclosing aggregates of magnetite and leucoxene (Fig. 16). It is thus evident that at least a portion of the opaque iron minerals represents the alteration product of augite. This is further confirmed by the fact that the olivine of this rock is optically positive. If the whole of the magnetite was primary and the magma so rich in iron, then the olivine ought to have been a fayalite which is negative. Similar olivine seems to have been observed by Dr. Coulson[10] in the olivine-basalt, of Post-Erinpura-Granite age, in the Sirohee State. He could not account for the positive character of the olivine in the rock containing

[10] A. L. Coulson, *op. cit.*, p. 96.

" abundant iron and possibly some manganese ", for he says, "the mineral may be fayalite though it is positive in optical character."

This rock differs from the olivine-dolerite in possessing no augite at all. The typical structure of a basalt is present, and the groundmass is mostly composed of opaque minerals, like magnetite, ilmenite and leucoxene, with calcite and microlites of felspar. There seems to be a gradation in the alteration of the ferro-magnesian mineral, olivine. In the Danta area to the west, olivine phenocrysts are quite fresh (Fig. 15) ; whereas in the Sai river to the extreme east, olivine is totally altered and replaced by calcite. In the Godda area—lying between the above two areas, an intermediate stage of alteration is observed. Here olivine is present but it is all serpentinized (Fig. 14). It is interesting to note the total absence of augite in this rock, but it appears from the examination of the slides, described above, that the augite was probably in the groundmass but it has been completely altered. The various stages of the alteration and replacement of titaniferous augite finally leading to magnetite, ilmenite and calcite have been already traced in the case of olivine-dolerite and described in this paper (see pages 372, 373). The dykes of this rock occur in association with those of olivine-basalt in the bed of the Sai river. It can, therefore, be definitely said that the two rock-types are the same and they differ only in the stage of alteration of augite. It is not clear as to why the whole of the augite in the olivine-basalt was altered, whereas that was not the case in the olivine-dolerite.

From their un-metamorphosed nature and correlation with similar rocks of the neighbouring Sirohee State, the olivine-dolerite and olivine-basalt of Danta State are assigned to Post-Erinpura-Granite age. No dykes or veins of these rocks have, however, been discovered traversing the Erinpura-granite of Danta State, though masses of Erinpura-granite occur in the neighbourhood of every outcrop of these rocks. It may be that the calc-series afforded easy channels for these intrusions which were comparatively very small in dimensions. The solid mass of Erinpura granite was probably too hard for these intrusions to cut through.

Conclusion.

The basic intrusives of Danta State can thus be classified into the following types according to their structural and mineralogical characters. These rock-types may also represent the three basic phases of igneous activity in this area during the Post-Aravalli period :—

1.	Oldest intrusives (Post-Aravalli, but Pre-Granitoid-Gneiss, in age).	Pyroxene-granulite, Epidiorite and Hornblende-schist.
2.	Older intrusives (Post-Granitoid-Gneiss, but Pre-Erinpura-Granite, in age).	Meta-gabbro and Meta-dolerite.
3.	Younger intrusives (Post-Erinpura-Granite in age).	Olivine-dolerite and Olivine-basalt.

The younger intrusives of olivine-dolerite and olivine-basalt afford an interesting study in the alteration and replacement of pyroxene.

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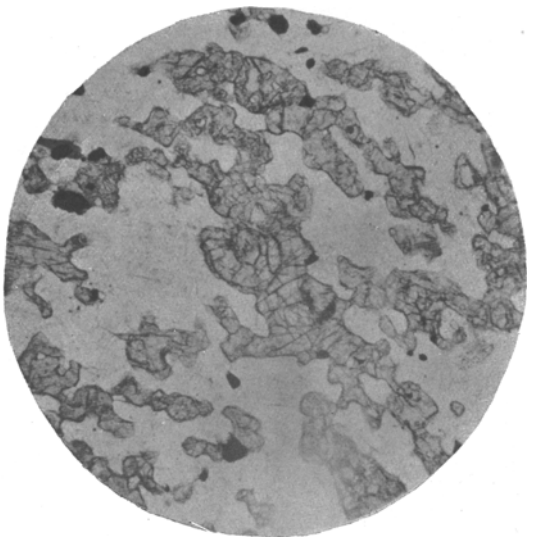
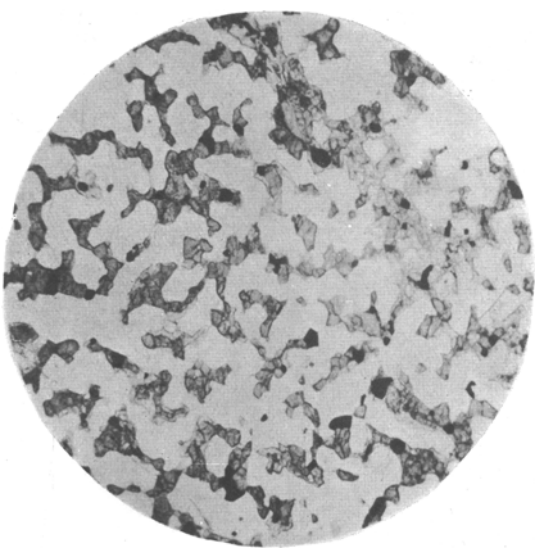
(Fig. 1.)
Epidiorite showing relict ophitic structure and absorption of alkali from felspar laths by hornblende which is more blue (here darker grey) along the margin. (Sp. No. D/9).
Plane polarised light × 20.

(Fig. 2.)
Hornblende-schist showing glomero-porphyroblasts of hornblende in a lepidoblastic groundmass (Sp. No. D/190).
Plane polarised light × 20.



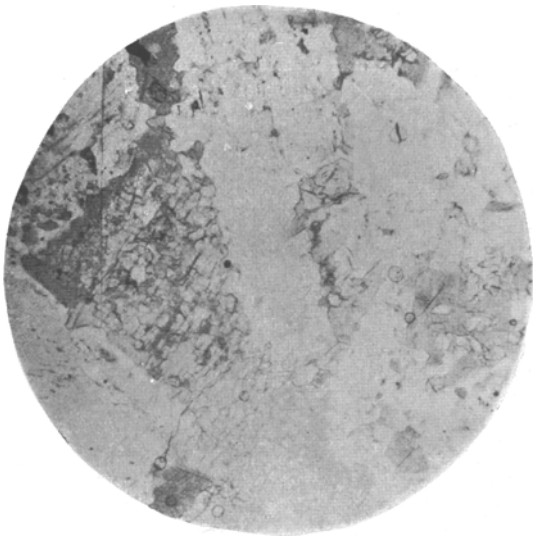
(FIG. 3.)

Pyroxene-granulite showing granulitic structure (Sp. No. D/379). Plane polarised light × 20.

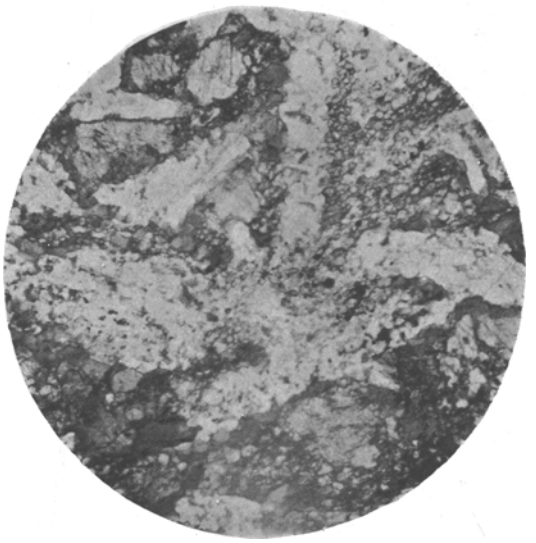


(FIG. 4.)

Garnet-granulite showing grossularite surrounded by epidote (Sp. No. $D^1/56$). Plane polarised light × 20.



(FIG. 5.)
Meta-gabbro showing ophitic structure and pyroxene altering to hornblende (Sp. No. $D^1/51$).
Plane polarised light × 20.



(FIG. 6.)
Meta-gabbro showing ophitic structure, and cataclastic diallage (Sp. No. D/452).
Plane polarised light × 20.

(Fig. 7.)
Olivine-dolerite showing ophitic structure and titaniferous augite (Sp. No. D/545).
Plane polarised light × 20.

(Fig. 8.)
Olivine-dolerite showing interpenetration of laths of felspar (Sp. No. $D^1/61$).
Nicols crossed × 20.

(FIG. 9.)

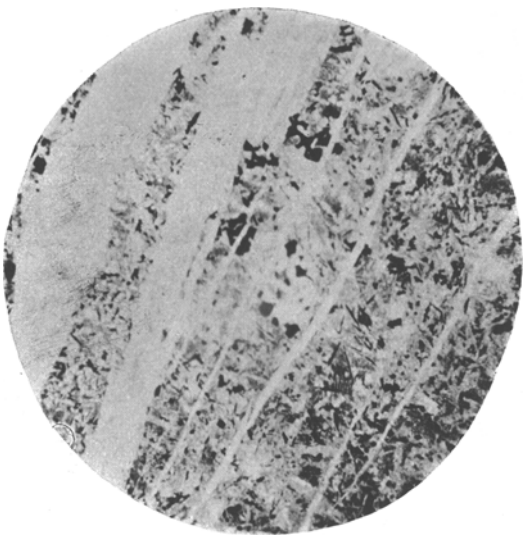
Olivine-dolerite showing ophitic felspar enclosing an aggregate of biotite, chlorite and magnetite (Sp. No. $D^1/63$).
Plane polarised light × 20.

(FIG. 10.)

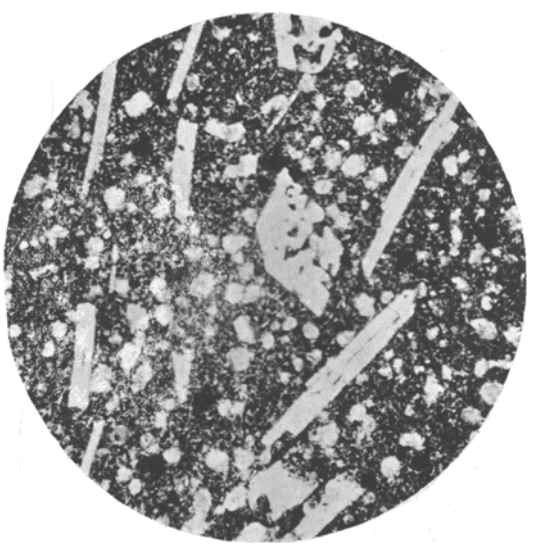
Olivine-dolerite showing amygdule-like calcite surrounded by chlorite (Sp. No. D/545).
Plane polarised light × 20.

(Fig. 11.)
Olivine-dolerite showing ophitic felspar enclosing triangular patches of pure calcite (Sp. No. $D^1/107$).
Nicols crossed × 20.

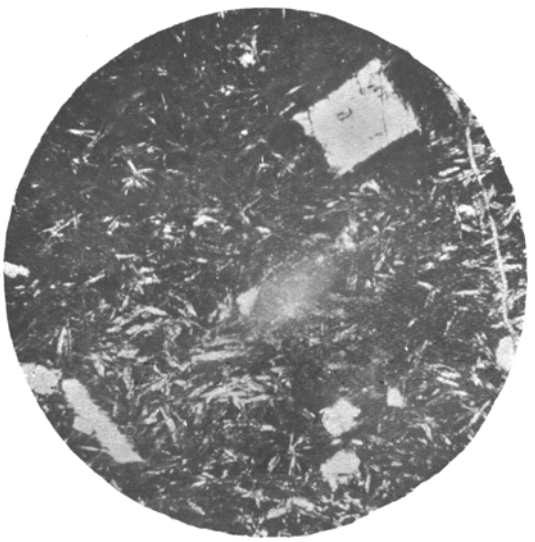
(Fig. 12.)
Olivine-dolerite showing crystals of altered olivine enclosed in felspar laths (Sp. No. $D^1/63$).
Plane polarised light × 20.



(Fig. 13.)
Olivine-basalt showing veinlets of calcite and needles and triangles of magnetite in the groundmass (Sp. No. D/105).
Plane polarised light × 20.



(Fig. 14)
Olivine-basalt showing laths of felspar, hexagonal section of serpentine and numerous amygdules of calcite (Sp. No. D/693).
Plane polarised light × 20.



(Fig. 15.)
Olivine-basalt showing microlites of felspar in the opaque groundmass, and rhomb of colourless olivine (Sp. No. D/446).
Plane polarised light × 20.

(Fig. 16.)
Olivine-basalt showing colourless olivine, ophitic felspar and almost opaque groundmass (Sp. No. D/446).
Plane polarised light × 20.

The Coloured Plate (No. III) refers to an article on "***Plasmodium narayani*** N. Sp., Parasite of the Fish Otter ***Lutra lutra***" by Col. I. Froilano de Mello and Emerciano Dias appearing in Vol III, No. 3.